

The Future of Climate Change



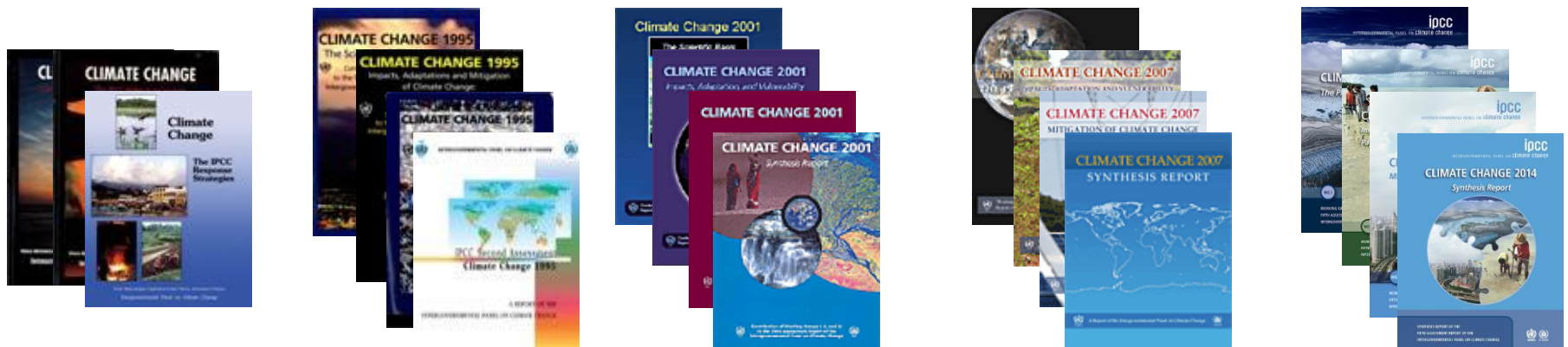
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Systems
School of Public Policy
Georgia Institute of Technology

Climate@Emory
Day of Scholarship
April 24, 2015

The Intergovernmental Panel on Climate Change (IPCC)

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- Provides policymakers with regular assessments of
 - the scientific basis of climate change,
 - its impacts and future risks, and
 - options for adaptation and mitigation
- Informs negotiations of the UN Framework Convention on Climate Change (UNFCCC)



Website for IPCC reports: <http://www.ipcc.ch/report/ar5/>

1990	▶	First Assessment Report (FAR)
1991		
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1995	▶	Second Assessment Report (SAR)
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2001	▶	Third Assessment Report (TAR)
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2007	▶	Fourth Assessment Report (AR4) <i>Nobel Peace Prize (shared with Al Gore)</i>
2008		
2009		
2010		
2011		
2012		
2013	▶	Fifth Assessment Report (AR5) <i>831 authors and editors</i>
2014		

- Established by World Meteorological Organization (WMO) and United Nations Environment Program (UNEP) in 1988
- Mandate from December '88 UN General Assembly resolution
- The IPCC is a scientific body under the auspices of the UN.
- “The IPCC ... is open to all member countries of the United Nations (UN) and WMO.”
(<http://www.ipcc.ch/organization/organization.shtml#.Uucv-Nlo4-U>)

1990



First Assessment Report (FAR)

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Second Assessment Report (SAR)

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Third Assessment Report (TAR)

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Fourth Assessment Report (AR4)

Nobel Peace Prize (shared with Al Gore)

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Fifth Assessment Report (AR5)

831 authors and editors

2014

1990 ▶ First Assessment Report (FAR)

“The *unequivocal detection* of the enhanced greenhouse effect from observations is **not likely** for a decade or more.”

1991

1992

1993

1994

1995 ▶ Second Assessment Report (SAR)

“The **balance of evidence** suggests a *discernable human influence* on global climate.”

1996

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2000

2001 ▶ Third Assessment Report (TAR)

“There is **new and stronger evidence** that most of the warming observed over the last 50 years is attributable to *human activities*.”

2002

2003

2004

2005

2006

2007 ▶ Fourth Assessment Report (AR4)
Nobel Peace Prize (shared with Al Gore)

“Most of the observed increase is global average temperature since the mid-20th century is **very likely** due to the observed increase in *anthropogenic greenhouse gas concentrations*.”

2008

2009

2010

2011

2012

2013 ▶ Fifth Assessment Report (AR5)
831 authors and editors

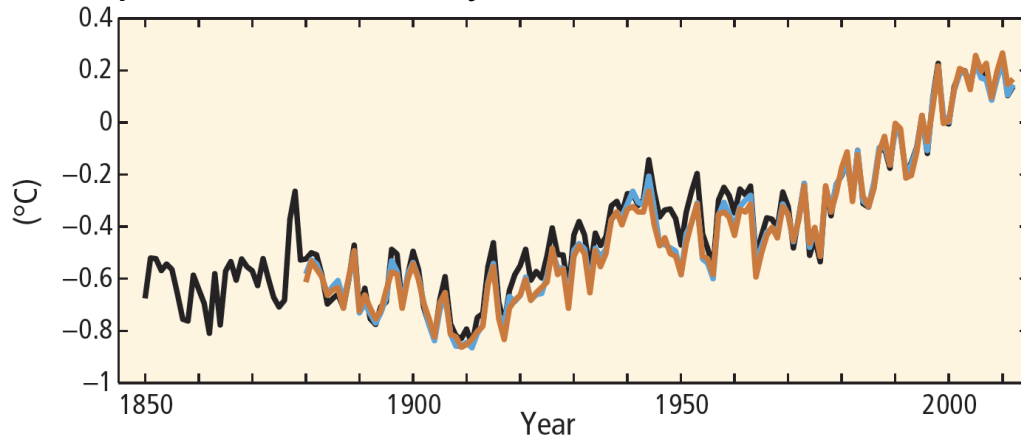
“It is **extremely likely** that more than half of the observed increase in global average surface temperature from 1951 to 2010 was caused by the *anthropogenic increase in greenhouse gas concentrations* and other anthropogenic forcings together.”

2014

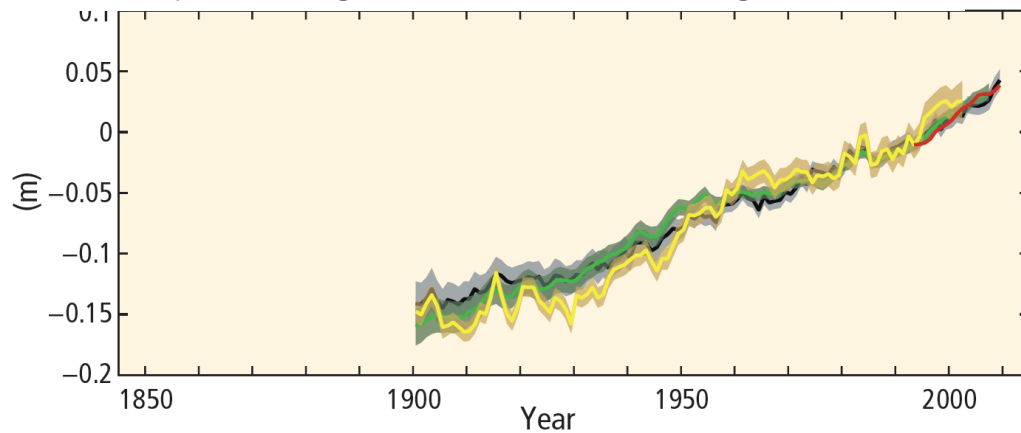
Observed Trends

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Globally averaged land & ocean temperature anomaly



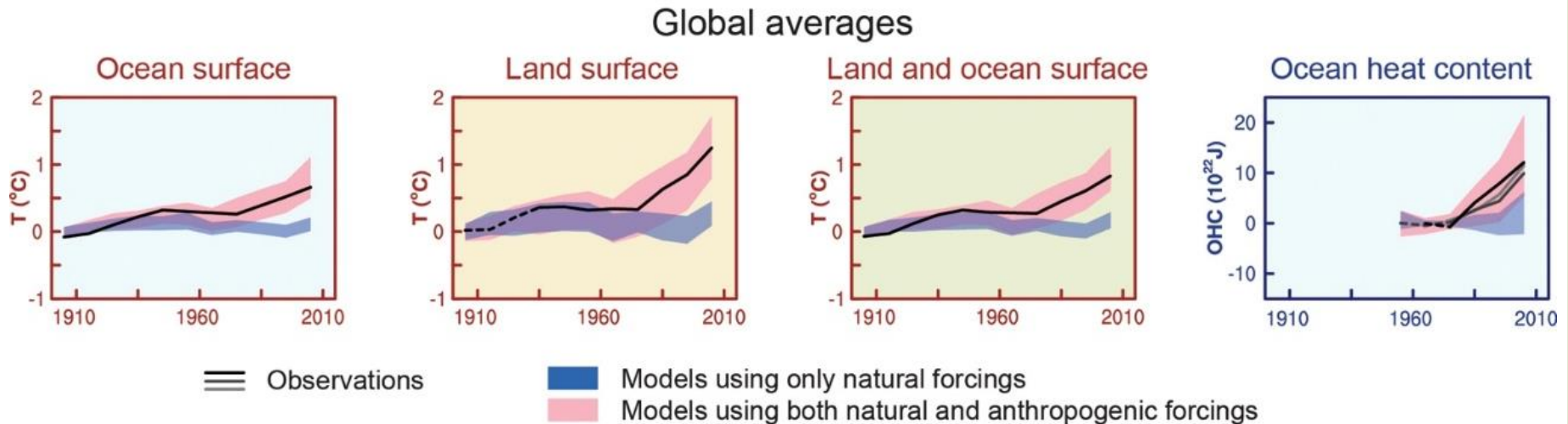
Globally averaged sea level change



- Warming is unequivocal
- +0.85° C since 1880
- 1983-2012 *likely* the warmest period since 1400
- Ocean heat content is increasing
- Sea-level rose by 0.19 m

Anthropogenic Forcings are Needed to Match Climate Models to Observations

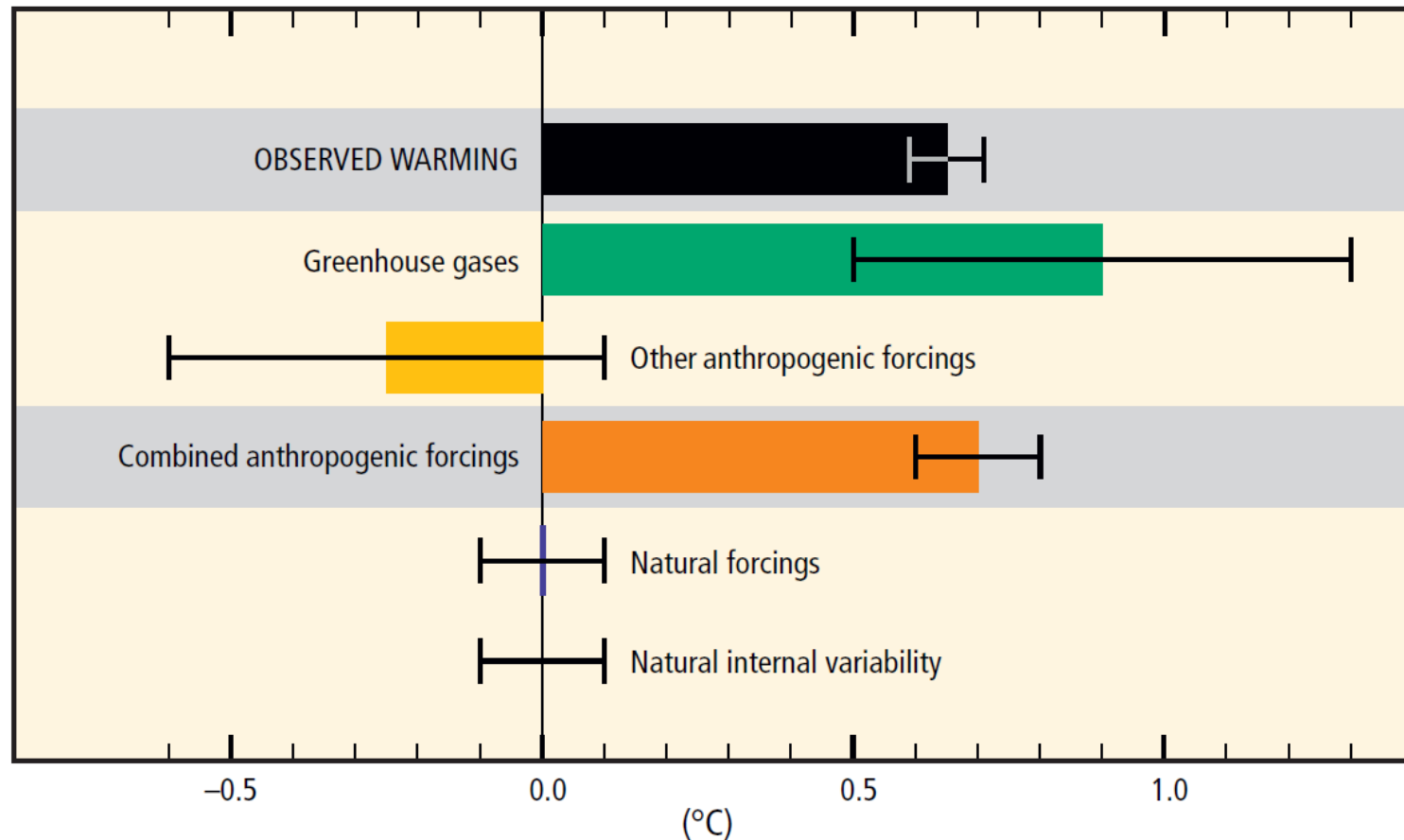
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Dissecting global warming

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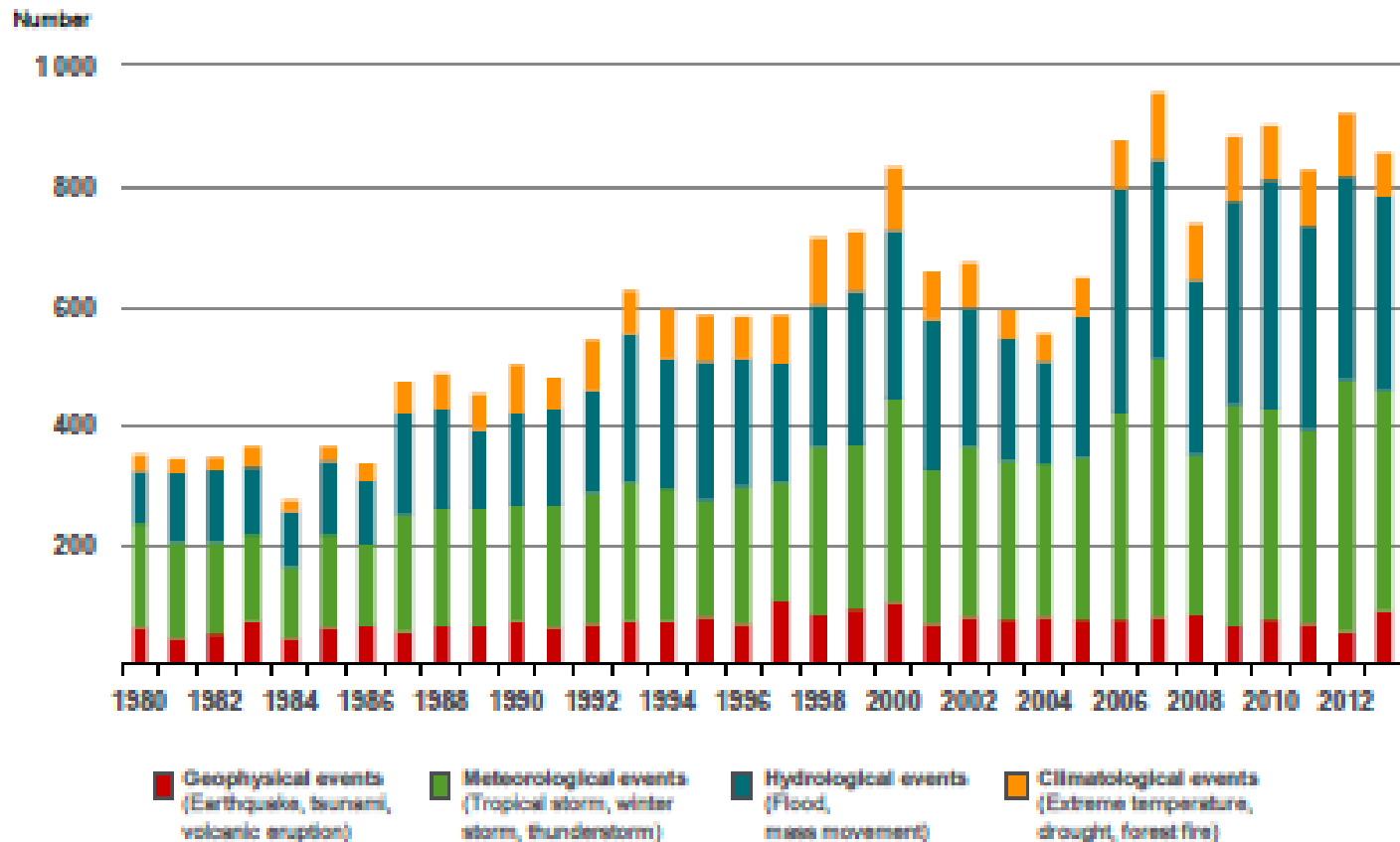
Contributions to observed surface temperature change over the period 1951–2010



Natural Catastrophes are Increasing in Frequency, Magnitude & Cost

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- Global Natural Catastrophes 1980-2013



Source: Munich RE, 2014, *2013 Natural Catastrophe Year in Review*.

Increased Flooding is Forecast



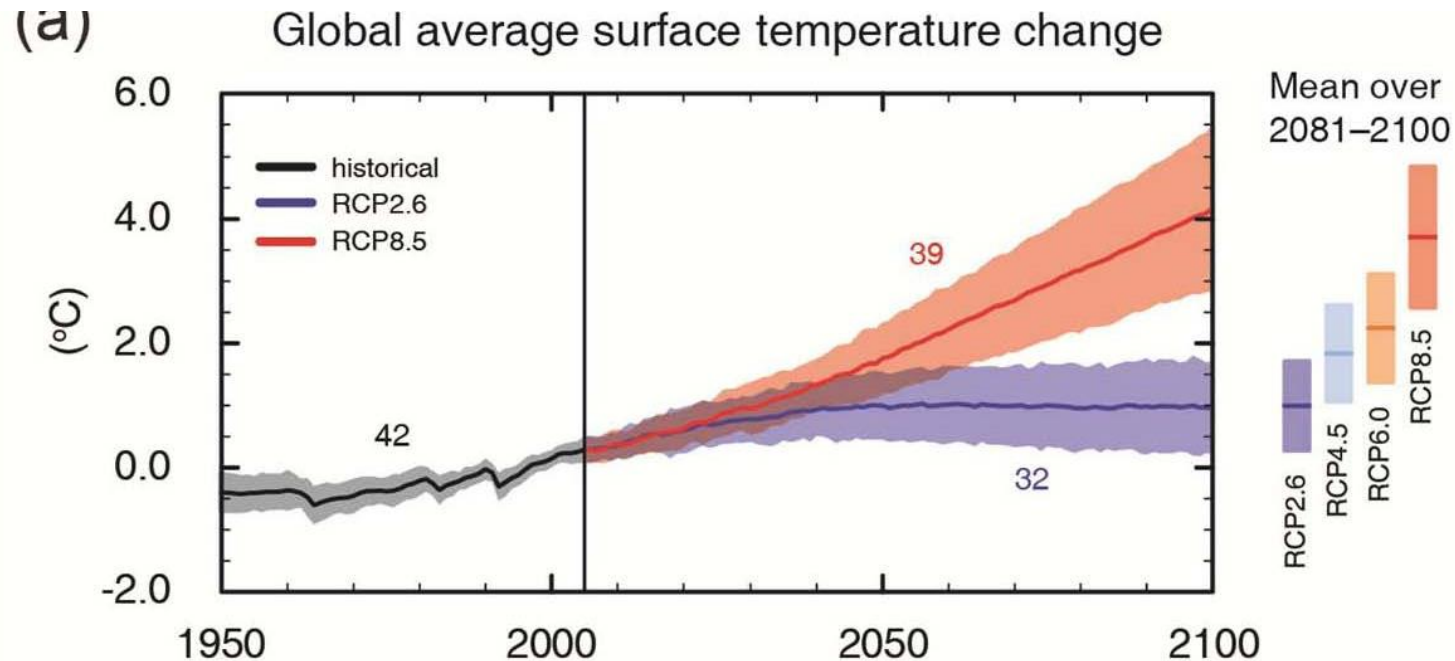
Of the 50 states, Florida is the most vulnerable to rising sea levels, standing just a few feet above the current level. Miami is in an especially dangerous position because of its porous limestone foundation.

Source: http://www.nytimes.com/interactive/2014/03/27/world/climate-rising-seas.html?_r=1

Global Surface Temperature Projections

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Global surface temperature change for the end of the 21st century is *likely* to exceed 1.5°C relative to 1850 to 1900 for all RCP scenarios except RCP2.6. Warming will continue beyond 2100 under all RCP scenarios except RCP2.6.



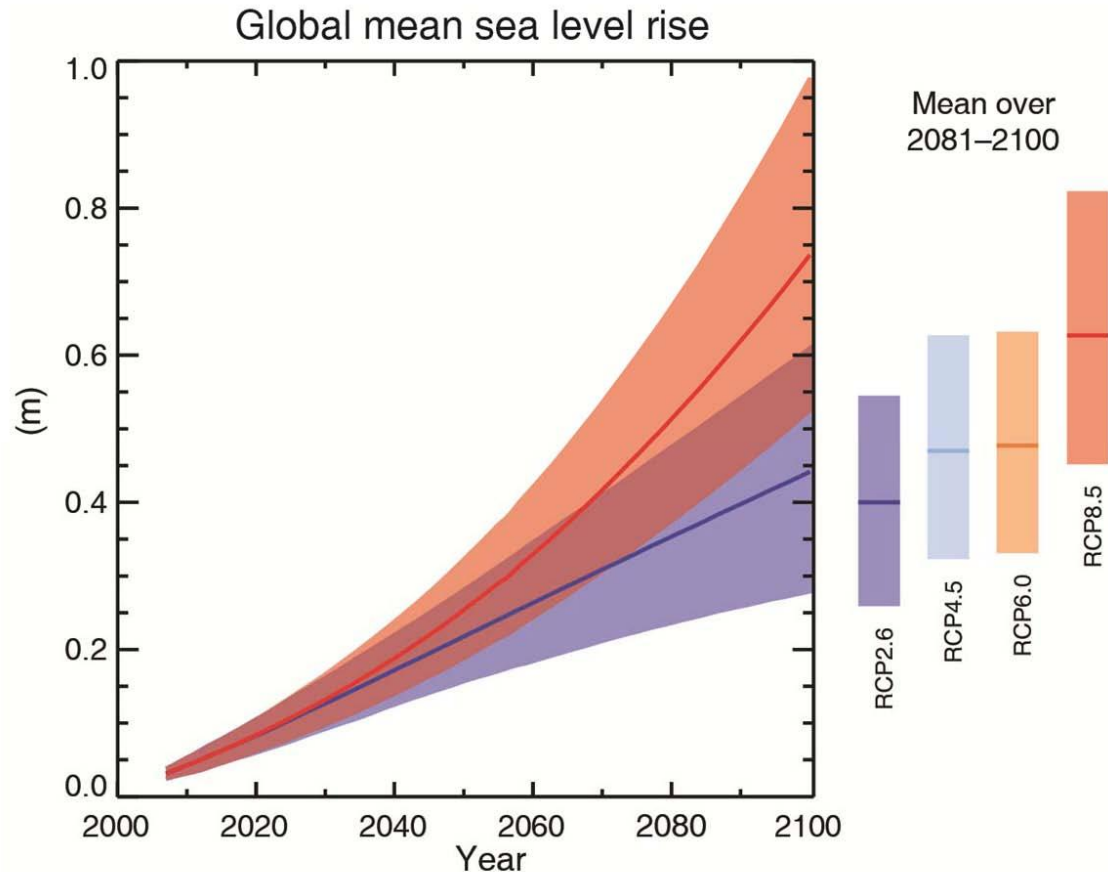
Source: IPCC. RCP = Representative Concentration Pathway (+ total radiative forcing in 2100 relative to 1750)

Projected Sea Level Rise

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Global sea level is expected to rise at an increasing rate.

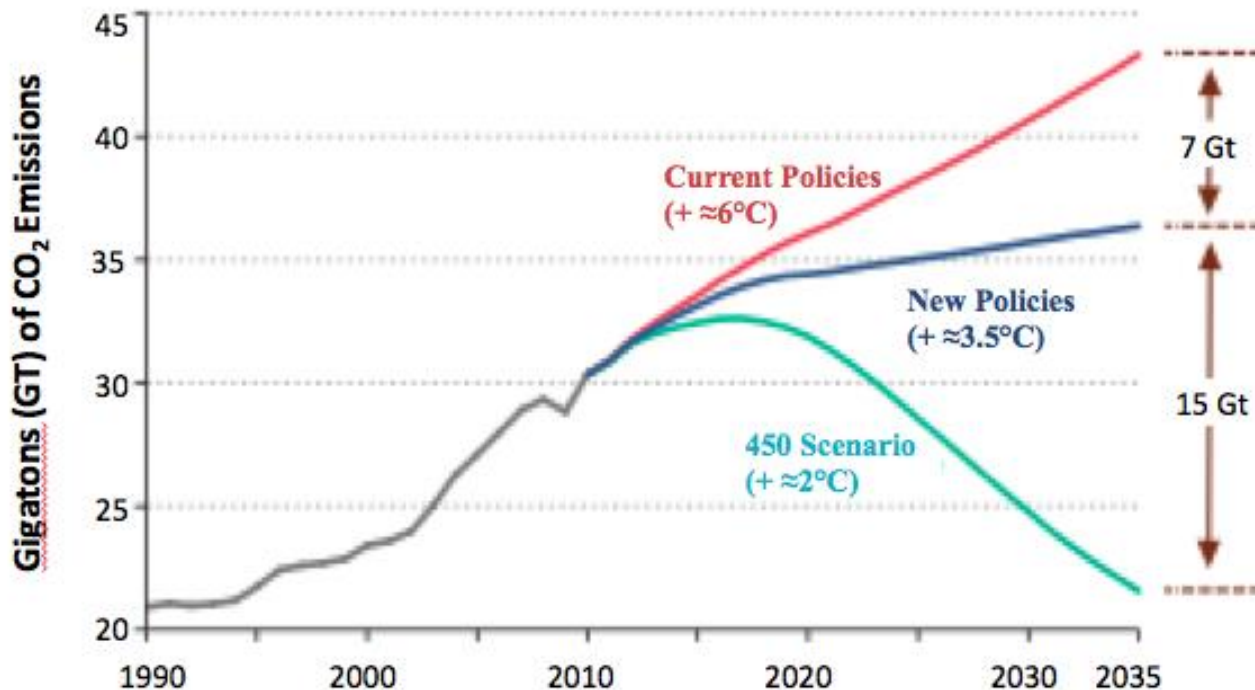
Over the last two decades, the Greenland and Antarctic ice sheets have been losing mass, glaciers have continued to shrink almost worldwide, and Arctic sea ice has continued to melt.



The Door is Closing on 450 ppm CO₂ (or a 2° C Rise in Global Temperatures)

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Four-fifths of the total energy-related CO₂ emissions of the 450 Scenario are already “locked-in” by existing capital stock



World Energy-Related CO₂ Emissions by Scenario

Source: International Energy Agency. 2011. *World Energy Outlook*.

IPCC Informs International and Domestic Climate Policy



IPCC (2007)



Group of 8 (2009)



U.S. Goal (2009-2010)



U.S. Regulations (2013-)

Table SPM.5: Characteristics of post-TAR stabilization scenarios [Table TS 2, 3.10]⁹⁴

Category	Radiative forcing (W/m ²)	CO ₂ concentration ^(c) (ppm)	CO ₂ concentration ^(c) (GtC)	Global mean temperature		Change in global CO ₂ emissions in 2050 (% of 2000 emissions) ^(d)	No. of assessed scenarios
				2015	2060		
I	2.5-3.0	350-400	44	4.9-6.1	2060-2090	-85 to -50	6
II	3.0-3.5	400-440	49	4.9-6.1	2060-2090	-60 to -30	18
III	3.5-4.0	440-485	53	4.9-6.1	2060-2090	-30 to +5	21
IV	4.0-5.0	485-570	59	4.9-6.1	2060-2090	+10 to +60	118
V	5.0-6.0	570-660	710	4.9-6.1	2060-2090	+25 to +85	9
VI	6.0-7.5	660-790	855-1130	4.9-6.1	2060-2090	+90 to +140	5
Total							177

Global CO₂ reductions in 2050 of 50-85% consistent with warming of 2 to 2.4 degrees Celsius

"G8 leaders agreed to reduce their emissions 80% or more by 2050 as its share of a global goal to lower emissions 50% by 2050, acknowledging the broad scientific view that warming should be limited to no more than two degrees Celsius."

Reduce emissions by 83% by 2050 relative to 2005 (U.S. Copenhagen Accord submission; U.S. Legislative proposals)

Climate Action Plan: pursue executive actions to reduce carbon pollution, e.g., "...establish carbon pollution standards for both new and existing power plants."



Global
43,185,900,000
metric tons



15,000,000,000

United States
6,797,200,000

Southeast
1,934,720,000



Georgia
230M

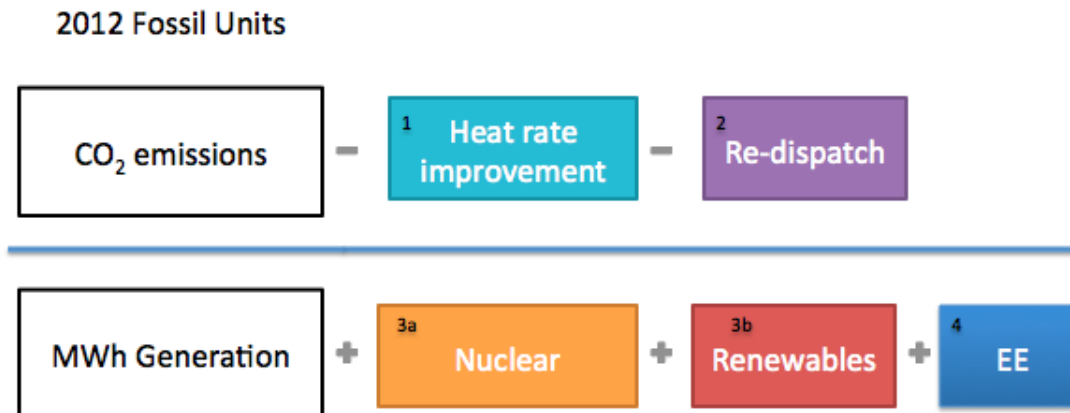
Source: Daniel Rochberg. 2015. Emory University

New U.S. Policies are Emerging: Clean Power Plan (CPP)

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- The CPP seeks to slash carbon emissions from existing U.S. power plants by 30% from 2005 levels by 2030.
- In the CPP, EPA proposed state-specific limits on CO₂ emissions from existing fossil fuel plants

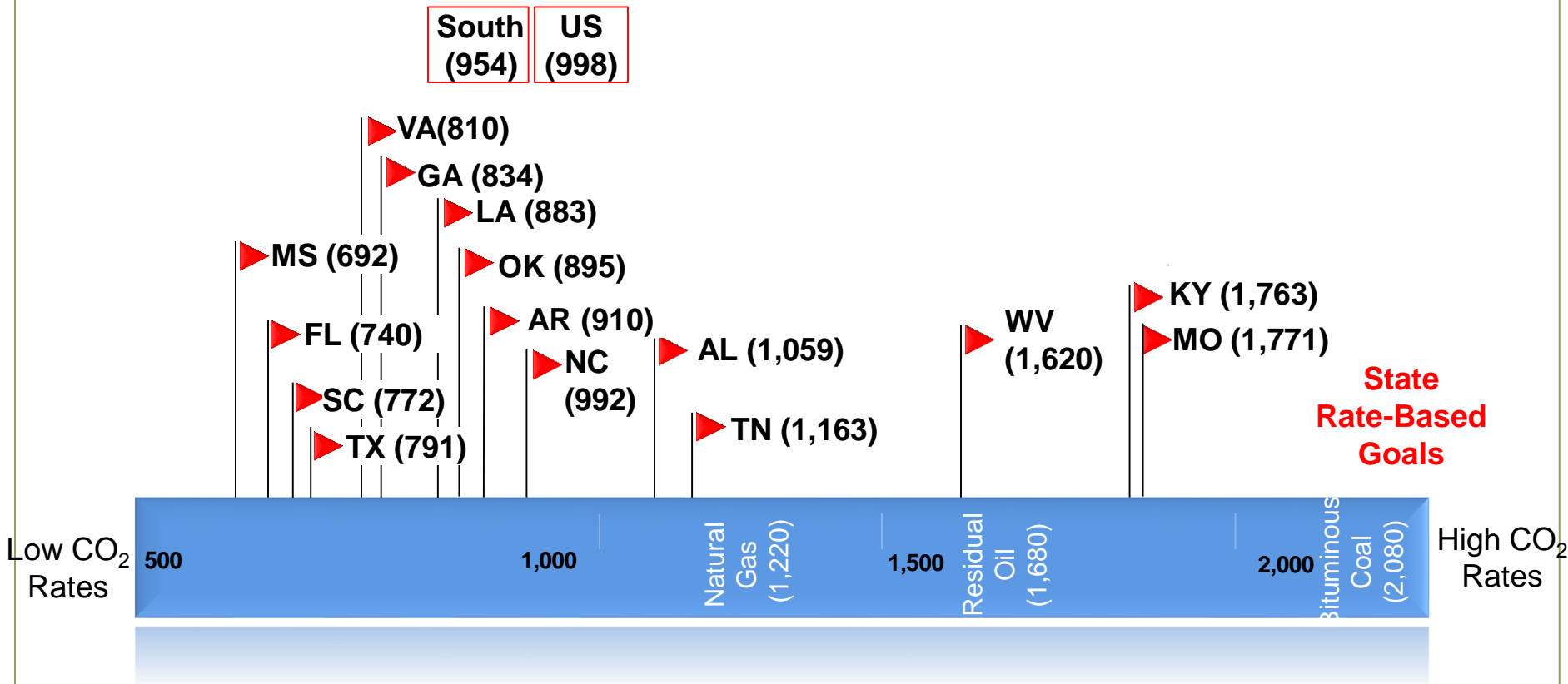
How the Goals were Calculated



See more analysis of the Clean Power Plan, by Georgia Tech:
<http://cepl.gatech.edu/drupal/node/75>

The Cost of CPP Compliance Appears to be Higher in the South

CO₂ Rate-Based Goals and Carbon Intensity of Fuels (Lbs-CO₂/MWh):



The White House Climate Pledge to the UNFCCC (March 31, 2015)

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- The U.S. will seek to cut its GHG emissions by 26% to 28% from 2005 levels by 2025, in a target submitted to the UNFCCC.
- This U.S. Intended Nationally Determined Contribution (INDC) compares to the Obama administration's 2009 commitment to reduce emissions by 17% below 2005 levels by 2020.
- It is consistent with the November agreement between President Obama and Chinese President Xi Jinping.

Benefits Achieved by the U.S. Target

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- On 4/7/15, a White House fact sheet on the INDC noted that the Clean Power Plan seeks to deliver \$55 billion to \$93 billion in annual net benefits by reducing carbon pollution and other harmful pollutants.

Pledges To Date: More is Needed to Meet the 15 Billion Ton Goal

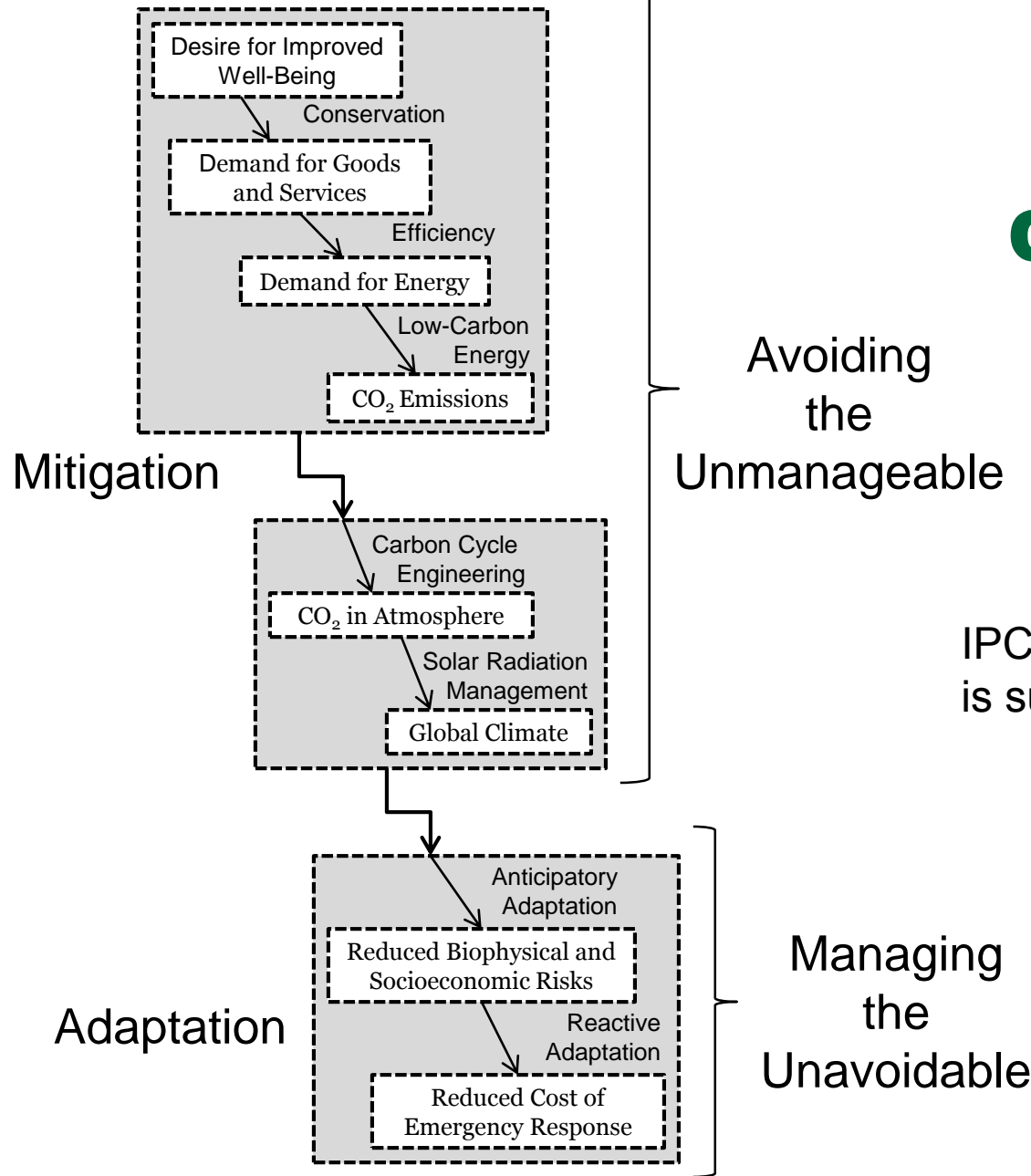
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By the informal deadline set by the United Nations in 2013, 33 countries had submitted plans to fight climate change beyond 2020.

Country/Region	Pledge	Target year
USA	Economy-wide Kyoto GHGs 26-28% below 2005	2025
EU	Economy-wide Kyoto GHGs 40% below 1990	2030
China	Peak in total CO ₂	2030
Mexico	Economy-wide Kyoto GHGs & Black Carbon 25% below BAU	2030
Russia	Economy-wide Kyoto GHGs 25-30% below 1990	2030
Gabon	CO ₂ +CH ₄ +N ₂ O 50% below BAU	2025
Norway	Economy-wide Kyoto GHGs 40% below 1990	2030
Switzerland	Economy-wide Kyoto GHGs 50% below 1990	2030

Discussion about comparability, ambition, compatibility, participation, verification, compensation, etc.

Adaptation & Mitigation: Complementary Strategies

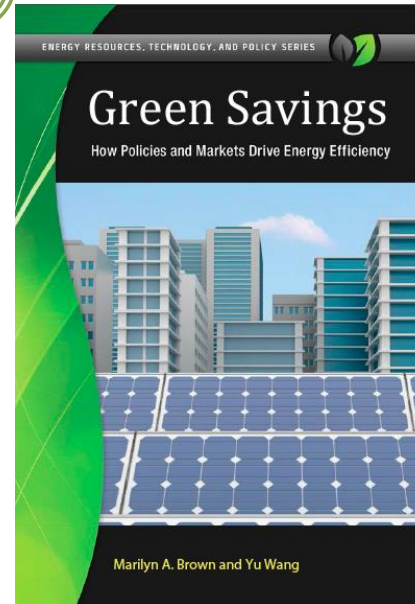


IPCC/SPM: “no single option is sufficient by itself.”

For More Information

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Climate Change and Global Energy Security

Technology and Policy Options

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Benjamin K. Sovacool

